

CLAIMS:

1. A servo system for controlling position of a sensor assembly (30) in a data readout and/or writing device (10, 500), the device (10, 500) including:

(a) at least one actuating means (28, 36) for spatially actuating a structural assembly(22) and its associated sensor assembly (30),

5 the system further comprising:

(b) controlling means (34) in communication with said at least one actuating means (28, 36) for controlling spatial movement of the structural assembly (22) and the sensor assembly (30),

the controlling means (34) being operable:

10 (d) to apply substantially velocity feedback control to said at least one actuating means when the sensor assembly is substantially remote from a desired target position; and

(e) to apply substantially position feedback control to said at least one actuating means when the sensor assembly is substantially spatially proximate to said target position, the controlling means further including pole-compensating filtering means (126) for at least

15 partially compensating response poles of the structural assembly (22) and its sensor assembly (30) so as to result during operation of the system in smoother switching between said substantially velocity feedback control and said position feedback control for enhancing at least one of temporal and spatially responses of the system when controlled by the controlling means (34).

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2. A system according to Claim 1, wherein the device is at least a bi-mass configuration wherein said at least one actuating means (28, 36) comprises:

(a) first actuating means (36) for spatially actuating the structural assembly (22);
and

25 (b) second actuating means (28) interposed between a movable actuated region of the structural assembly (22) and the sensor assembly (30) for actuating the sensor assembly (30) relative to the actuated region,

the system further being arranged such that:

(c) said controlling means (34) is coupled in communication with the first and second actuating means (28, 36) for controlling spatial movement of the structural assembly (22) and the sensor assembly (30),

the controlling means (34) being operable:

5 (d) to apply substantially velocity feedback control to the first and second actuating means (28, 36) when the sensor assembly (30) is substantially remote from the desired target position; and

(e) to apply substantially position feedback control to the first and second actuating means (28, 36) when the sensor assembly (30) is substantially spatially proximate
10 to said target position,

the controlling means (34) further including the pole-compensating filtering means (126) for at least partially compensating response poles of the bi-mass system so as to result during operation of the system in smoother switching between said substantially velocity feedback control and said position feedback control for enhancing at least one of
15 temporal and spatially responses of the system when controlled by the controlling means (34).

3. A system according to Claim 2, wherein the first actuating means (36) is arranged to provide a larger spatial actuation dynamic range than the second actuating means
20 (28), and the second actuating means (28) acting upon the sensor assembly (30) is arranged to provide a more rapid temporal response than the first actuating means (28) acting upon the structural assembly (22) and thereby on the second actuating means (28) and its associated sensor assembly (30).

25 4. A system according to Claim 2, wherein the second actuating means (28) is arranged to exhibit a smaller spatial dynamic range than the first actuating means (36).

5. A system according to Claim 1, wherein the velocity feedback control is implemented substantially as a proportional-integral PI feedback control loop (122, 124).
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6. A system according to Claim 1, wherein the position feedback control is implemented substantially as a proportional-integral-differential PID feedback control loop (128) subject to the pole-compensating filtering means (126).

7. A system according to Claim 1, wherein the controlling means (34) is operable to render the second actuating means (28) slave to the first actuating means (36) in said velocity feedback control, and to render the first actuating means (36) slave to the second actuating means (28) in said position feedback control.

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8. A system according to Claim 1, wherein the controlling means (34) is operable:

(a) to apply an acceleration process and a subsequent deceleration braking process to the first actuating means (36); and

10 (b) to switch between said velocity feedback control and said position feedback control when the sensor assembly (30) assumes at least one of a pre-defined threshold velocity and a pre-defined spatial error between the sensor assembly (30) and the target position.

15 9. A system according to Claim 1, wherein data corresponding to pole responses of the structural assembly is recorded digitally as pole-response data, and the controlling means (34, 600) is implemented digitally to utilize said pole-response data.

10. A system according to Claim 1, wherein said controlling means (34) is
20 arranged to exhibit a damping factor in a range of 0.6 to 1.3 when switching between velocity feedback control and position feedback control.

11. A system according to Claim 10, wherein the controlling means (34) is
25 arranged to be substantially critically damped when switching between the velocity feedback control and the position feedback control.

12. A system according to Claim 1, wherein the pole-compensating filtering means (126) is arranged to at least partially compensate at least one open-loop response pole of the structural assembly (22) in combination with the actuating means (28, 36) and the
30 sensor assembly (30) by applying corresponding response-zeros to the controlling means (34).

13. A system according to Claim 1 incorporated into one or more of a CD reading and/or writing device (10, 500) for controlling the sensor assembly (30) implemented as an

optical unit (32) within the device, the device (10, 500) being operable to read data from and/or write data to CDs (14, 520).

14. A system according to Claim 1 incorporated into one or more of a DVD
5 reading and/or writing device (10, 500) for controlling the sensor assembly (30) implemented as an optical unit (32) within the device (10, 500), the device (10, 500) being operable to read data from and/or write data to DVDs (14, 520).

15. A system according to Claim 1, the system being adapted for controlling one
10 or more of a pick-and-place robot, a crane and a machine tool.

16. A system according to Claim 1, wherein at least one of the structural assembly
(22), the actuating means (28, 36) and the sensor assembly (30) is provided with spatial
position, velocity, rotation and/or acceleration measuring means for use by the controlling
15 means (34) in controlling spatial location of the sensor assembly (30).

17. A method of servo-control for controlling position of a sensor assembly (30)
in a data readout and/or writing device (10, 500), the device (10, 500) including:

(a) at least one actuating means (28, 36) for spatially actuating a structural
20 assembly (22) and its associated sensor assembly (30),

(b) controlling means (34) in communication with said at least one actuating
means (28, 36) for controlling spatial movement of the structural assembly (22) and the
sensor assembly (30),

the method comprising the steps of arranging for the controlling means (34):

(d) to apply substantially velocity feedback control to said at least one actuating
25 means (28, 36) when the sensor assembly (30) is substantially remote from a desired target
position; and

(e) to apply substantially position feedback control to said at least one actuating
means (28, 36) when the sensor assembly (30) is substantially spatially proximate to said
30 target position,

the controlling means (34) further including pole-compensating filtering
means (126) for at least partially compensating response poles of the structural assembly (22)
and its sensor assembly (30) so as to result during operation of the device (10, 500) in
smoother switching between said substantially velocity feedback control and said position

feedback control for enhancing at least one of temporal and spatially responses of the device (10, 500) when controlled by the controlling means (34).

18. A method according to Claim 17, wherein the device (10, 500) is at least a bi-mass configuration wherein said at least one actuating means (28, 36) comprises:

(a) first actuating means (36) for spatially actuating the structural assembly (22);
and

(b) second actuating means (28) interposed between a movable actuated region of the structural assembly (22) and the sensor assembly (30) for actuating the sensor assembly (30) relative to the actuated region,

such that:

(c) said controlling means (34) is coupled in communication with the first and second actuating means (28, 36) for controlling spatial movement of the structural assembly (22) and the sensor assembly (30),

and such that the controlling means (34) is operable:

(d) to apply substantially velocity feedback control to the first and second actuating means (28, 36) when the sensor assembly (30) is substantially remote from the desired target position; and

(e) to apply substantially position feedback control of the first and second actuating means (28, 36) when the sensor assembly (30) is substantially spatially proximate to said target position,

the controlling means (34) further including pole-compensating filtering means (126) for at least partially compensating response poles of the bi-mass configuration so as to result during operation of the device in smoother switching between said

substantially velocity feedback control and said position feedback control for enhancing at least one of temporal and spatially responses of the device when controlled by the controlling means (34).

19. A method according to Claim 18, wherein the first actuating means (36) is arranged to provide a larger spatial actuation dynamic range than the second actuating means (28), and the second actuating means (28) acting upon the sensor assembly (30) is arranged to provide a more rapid temporal response than the first actuating means (36) acting upon the structural assembly (22) and thereby on the second actuating means (28) and its associated sensor assembly (30).

20. A method according to Claim 18, wherein the second actuating means (28) is arranged to exhibit a smaller spatial dynamic range than the first actuating means (36).

5 21. A method according to Claim 17, wherein the velocity feedback control is implemented substantially as a proportional-integral PI feedback control loop (122, 124).

22. A method according to Claim 17, wherein the position feedback control is implemented substantially as a proportional-integral-differential PID feedback control loop
10 (128) subject to the pole-compensating filtering means (126).

23. A method according to Claim 17, wherein the controlling means (34) is operable to render the second actuating means (28) slave to the first actuating means (36) in said velocity feedback control, and to render the first actuating means (36) slave to the
15 second actuating means (28) in said position feedback control.

24. A method according to Claim 17, wherein the controlling means (34) is operable:

- (a) to apply an acceleration process and a subsequent deceleration braking process
20 to the first actuating means; and
- (b) to switch between said velocity feedback control and said position feedback control when the sensor assembly (30) assumes at least one of a pre-defined threshold velocity and a pre-defined spatial error between the sensor assembly (30) and the target position.

25 25. A method according to Claim 17, wherein data corresponding to pole responses of the structural assembly (22) is recorded digitally as pole-response data, and the controlling means (34) is implemented digitally to utilize said pole-response data.

30 26. A method according to Claim 17, such that said controlling means (34) is operable to exhibit a damping factor in a range of 0.6 to 1.3 when switching between velocity feedback control and position feedback control.

27. A method according to Claim 26, wherein the controlling means (34) is arranged to be substantially critically damped when switching between the velocity feedback control and the position feedback control.

5 28. A method according to Claim 17, wherein the pole-compensating filtering means (126) is arranged to at least partially compensate at least one open-loop response pole of the structural assembly (22) in combination with the actuating means (28, 36) and the sensor assembly (30) by applying corresponding response-zeros to the controlling means (34).

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29. A method according to Claim 17 applied in one or more of a CD read and/or write device (10) for controlling the sensor assembly (30) implemented as an optical unit (32) within the device (10, 500), the device (10, 500) being operable to read and/or write data to CDs (520).

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30. A method according to Claim 17 applied in one or more of a DVD read and/or write device (10, 500) for controlling the sensor assembly (30) implemented as an optical unit (32) within the device (10, 500), the device (10, 500) being operable to read and/or write data to DVDs (520).

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31. A method according to Claim 17 adapted for controlling one or more of a pick-and-place robot, a crane and a machine tool.

32. A method according to Claim 17, wherein at least one of the structural
25 assembly (22), the actuating means (28, 36) and the sensor assembly (30) is provided with spatial position, velocity, rotation and/or acceleration measuring means for use by the controlling means (34) in controlling spatial location of the sensor assembly (34).